1987

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Staff Paper #162

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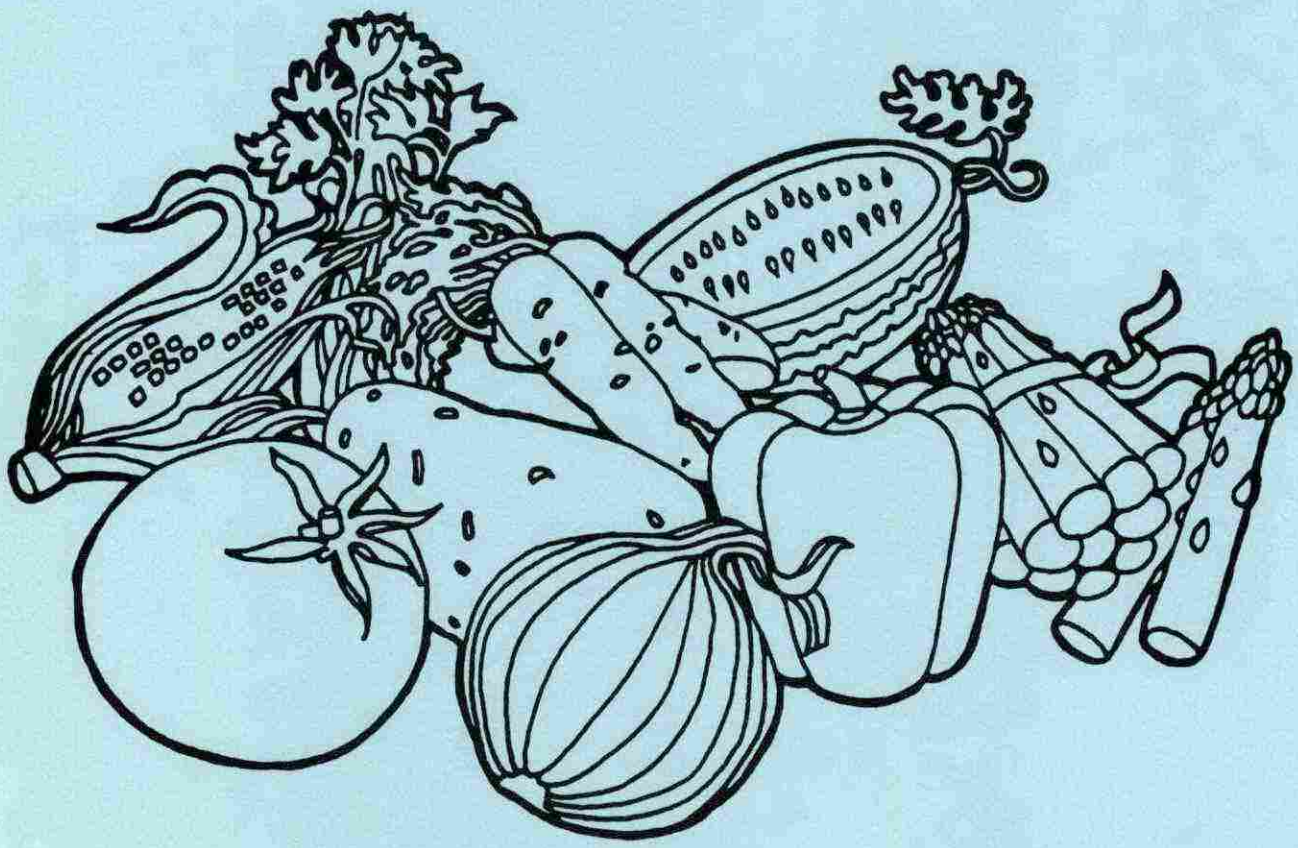

Cooperative Extension Service
Iowa State University
Ames, Iowa 50011

M-1248 | August 1987

The Economic Feasibility of Expanding Iowa's Fresh Vegetable Production for the Commercial Wholesale Market

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Market Research and Development Division
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U.S. Department of Agriculture

We wish to acknowledge the counsel, advice, and encouragement of Henry Taber, Extension Horticulturist, Charles Hall, Department of Horticulture Head, Roger Ginder, Professor of Economics, and Robert Jolly, Assistant Dean of Agriculture.

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Financial support partially provided by the Agricultural Marketing Service, U.S. Department of Agriculture.

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Introduction

The current financial crisis in midwestern agriculture has prompted farmers and policymakers to search for profitable alternative crops that can diversify Iowa's agriculture so that farmers and the state economy will be less reliant on corn, soybeans, cattle and swine. Among the alternative crops suggested for diversifying Iowa agriculture are fresh vegetables for the commercial wholesale market.

Although Iowa currently grows and sells a limited number of fresh vegetables commercially, most sales occur at roadside stands, farmers markets, or pick-your-owns, with some vegetables sold directly to local retailers (Hall, 1985). Any significant expansion of Iowa's production, however, would increase competition with commercial suppliers from other states in large volume wholesale and retail markets in Iowa and midwestern population centers. Analyzing the economic feasibility of competing effectively with the major producing states now supplying midwestern markets can indicate where the opportunities are greatest and where the potential disadvantages may be insurmountable.

A number of basic issues need to be addressed prior to making recommendations concerning the introduction of large scale fresh vegetable production to the Midwest. Other regions of the country have become very specialized in the production of certain vegetables both year round and in seasonal markets. Other states currently supply more than 90 percent of Iowa's summertime commercial wholesale market (Valley, 1985). In order to evaluate Iowa's economic potential in expanding fresh vegetable production,

the costs of vegetable production and transportation costs from these states to the midwest markets must be examined. If Iowa producers can grow and market the product for less than producers in the other states, then the potential for expansion in Iowa exists.

Farmers who might switch from more traditional crops to the production of vegetables will often have little or no experience in fresh vegetable production. This lack of experience is an added risk that must be considered. Fresh vegetables are usually assumed to be both more profitable and exhibit more price and yield risk than do grain crops. During the planning process, most managers would like some measurement of the profit-risk tradeoff associated with alternative crops. Typical production-budget cost estimates indicate what up-front or preharvest variable costs are associated with producing fresh vegetables compared with producing corn and soybeans. If the crop is unmarketable for some reason (storm damage, disease, etc.), cost estimates can also show how much of the production costs are incurred before harvest. Larger preharvest costs imply a large loss from non-marketable crops.

The variability of profits for fresh vegetables and traditional crops can also be compared to give growers another estimate of the profit-risk tradeoff. Assuming the majority of operators prefer lower risk enterprises, crops that have a modest return and small year to year changes in profits will be preferred to crops with the same modest return and larger year to year changes in profits.

The market potential for fresh produce should be examined to determine price responsiveness at different production levels and the profit levels associated with that production. For example, certain fresh fruits and vegetables have been characterized in the past as boom and bust industries

(Spotton et al., 1986). Their cyclical price and production behaviors often result in severely low prices that may force some operators out of business.

Buyers' perceptions of quality also influence the market potential for certain vegetables. Buyers in the commercial wholesale market may have locational preferences because they perceive that produce from a particular area is of better quality or that the producers in certain regions are more reliable suppliers. If buyers perceive that midwestern produce is lower in quality, they may want to pay a lower price or may not accept the produce. Although vegetables may be available from a new producing area, they may not be considered a good substitute for produce from current suppliers. Thus, buyers' perceptions of quality can be a significant risk factor for commercial market entrants.

Currently some states seem to dominate the fresh vegetable industry. If one looks only at the overall production figures, California would seem to have a production advantage in a number of the fresh produce crops. California produces as much as 90 percent of annual U.S. production in crops such as cantaloupe and broccoli. Does California enjoy strictly a seasonal climatic advantage, or does it have lower costs in horticultural production even in the summer months? Have rising transportation costs erased any production-cost advantage which California might have in competing with Iowa producers. Could north-central states supply more of the summertime consumption, or can California producers consistently undercut midwestern producers due to lower costs and, thus, keep the Midwest out of commercial fresh production during the summertime? These are the issues and questions this study will address.

Objectives

This study examines Iowa's potential to expand its commercial wholesale fresh vegetable industry in the Midwest for 13 major vegetables: broccoli, snap beans, cabbage, sweet corn, cucumbers, leaf lettuce, muskmelon, green peppers, potatoes, summer and winter squashes, tomatoes, and watermelons. In particular this research will investigate:

a) Iowa's potential for self-sufficiency in each crop,

b) Iowa's ability to supply nearby metropolitan markets, (i.e., Chicago, Kansas City, Minneapolis, and St. Louis), and

c) The potential impacts of a larger vegetable industry upon Iowa income and the opportunities for small farmers to enter Iowa agriculture.

To address these issues, the following procedures will be used:

1) Iowa's current production levels and market channels will be explored to determine a basis for the potential expansion. By using estimates of Iowa's current volumes within each market channel, the potential for additional production to serve the local market can be approximated.

2) Iowa's current competitors in Iowa and major metropolitan markets in surrounding states will be determined.

3) Production cost estimates for Iowa and competing states will be developed in order to study relative production costs.

4) Local and nearby metropolitan area demand potential will be estimated.

5) Iowa's production and transportation costs to local and selected nearby markets will be compared to competing states' production and transportation costs to the same markets. In addition, the risk associated with production will be compared across regions to analyze

the effects of that risk on the amounts supplied from each region and on prices.

6) The nearby metropolitan market requirements and volume potential identified in the commercial wholesale buyer survey by Spotton et al. (1986) will be considered in determining the feasibility of successfully competing in those markets.

The Iowa Vegetable Market Situation

Iowa's 1984 vegetable production, and the market channels available, examined together, can help identify the potential for expansion. If the quantities of fresh vegetables demanded within a particular market segment can be estimated, and if the quantities of vegetables that are being grown for that particular channel can be established, then an expansion potential for that particular market can be estimated.

The structure of the market, with its three major channels--processing, direct-to-consumer (fresh), and commercial wholesale fresh--and the market requirements of those channels are important to growers wanting to enter the industry. Growers need to be able to identify their market outlet, and market requirement information is necessary for the product to conform to the rigid standards set in certain outlets and therefore be marketable.

Iowa production

Vegetable harvested-acreage estimates for Iowa are available for 1982 and 1985. The 1982 Census of Agriculture (U.S. Department of Commerce, 1984) lists the harvested acreage by crop and lists the number of fruit and vegetable growers in Iowa during that year, but does not indicate how the product is marketed. Those acreages are shown in Table 1.

Table 1. 1982 Iowa Fruits and Vegetables: Number of Farms and Acreages By Crop[a]

Crop	No. of Farms	Acres	Crop	No. of Farms	Acres
Broccoli	11	7	Green Peppers	40	75
Snap beans	51	34	Potatoes	149	1767
Cabbage	46	105	Squash	64	97
Sweet Corn	298	5619	Tomatoes	128	473
Cantaloupes	82	429	Watermelon	64	345
Cucumbers	40	29			
			Total Acres		8980

[a]Source: U.S. Dept. of Commerce, 1982 Census of Agriculture, 1984.

A second estimate of fruit and vegetable acreage was provided by Henry Taber, Iowa State University Extension Horticulturist, based upon his observations in 1985 (Hall, 1985). Taber's estimates approximate planted acreage, but actual harvested acreage is probably smaller. These estimates when used to calculate total production, therefore, probably overestimate harvested acreage because no adjustment is made for non-harvested acres. In addition, the yield estimates associated with these acreages are based on irrigated crops, whereas, according to the 1982 census, a high proportion of the acreage is not irrigated. These estimates are, nevertheless, more useful because he separates sweet corn, potatoes, and tomatoes for the processing market from the two fresh-market channels. These three crops have more estimated processing acreage than fresh acreage according to Hall (1985). Taber's fresh-market vegetable acreage estimates are shown in Table 2.

These two estimates of Iowa vegetable acreage are not strictly comparable because of the different sources, years, and techniques used to obtain the

Table 2. 1985 Iowa Fruits and Vegetables: Acres, Yield and Production[a]

Crop	Planted[b] Acres	Irrigated[c] Yield/Acre (cwts.)	Assumed Production (cwts.)
Broccoli	0	N.A.	N.A.
Snap beans	0	N.A.	N.A.
Cabbage	200	250	50,000
Sweet Corn	3700	95	351,500
Cucumbers	0	N.A.	N.A.
Leaf Lettuce	0	N.A.	N.A.
Muskmelons	800	150	120,000
Green Peppers	80	145	11,600
Potatoes	600	250	150,000
Squash, Pumpkins	250	300	750,000
Tomatoes	60	300	18,000
Watermelons	700	400	280,000
Total Acres	6390		

[a]Source: Hall, 1985.

[b]Assumes planted acres are completely harvested.

[c]Assumes crops are irrigated to obtain these yields.

data. However some general conclusions regarding the possibility of increased production for certain fresh-market vegetable channels can be reached.

In 1982, the average number of acres grown per farm of each vegetable was between .5 and 5 acres, with the exceptions of sweet corn and potatoes. The average sweet corn acreage was approximately 20 acres and average potato acreage was slightly less than 12 acres.

The 1982 Census of Agriculture gives the number of farms by size class. For all vegetables reported, excluding potatoes, there were 429 farms. Of these, 253 were less than 5 acres in size, and an additional 90 were less than 25 acres, leaving 86 farms that were 25 acres or more. Thus, vegetable

acreages per farm generally could be characterized as small, with a few larger farms.

Only 115 of the 429 farms growing vegetables were classified as vegetable farms according to the 1982 Census of Agriculture. Only 46 of the 115 vegetable farms had receipts greater than $10,000. Overall, 243 of the 429 farms that grew vegetables had receipts greater than $10,000, but the data do not detail what portion of the receipts came from vegetable sales.

Potato production followed a similar pattern. Most farms grew less than five acres of potatoes. Of 149 farms, 123 were less than 5 acres in size, an additional 13 were less than 25 acres, 10 were less than 100 acres, and only 3 were greater than 100 acres. Unfortunately, potatoes were included in a category with sugar beets, peanuts, hay, and other field crops, so there was no way to determine the number of potato operations that sold in the direct-to-consumer market.

For most of the crops studied, further analysis provides some insight into which market channel producers use. By studying the 1982 Census of Agriculture county data, the number of farms and acreages by crop per county can be determined. With the exceptions of sweet corn, potatoes, and tomatoes, the county information shows that the acreages per crop and farm are small and that only a limited number of the farms have enough acreage in any one crop to be potentially involved in the commercial wholesale channel. The remaining acreages that could be in the direct wholesale channel were still only a small amount of the total production necessary to meet in-state consumption needs. Also, only cantaloupe, tomatoes, and watermelon had significant irrigated acreages. Of the 8363 acres of vegetables grown in 1982 only 871 acres were irrigated. Irrigation is typically required to maintain a consistent

week-to-week supply and, thus, permit participation in the commercial wholesale market.

Specific production levels can not be clearly assigned to each market channel by using the statistics available. The data can, however, be used as a starting point for determining the Iowa expansion potential for fresh vegetables.

The Market Channels

Three major market channels are available to producers of fresh vegetables. These channels are the processing, direct-to-consumer, and the commercial wholesale fresh channels (Figure 1). The commercial wholesale fresh market is the primary focus of this study, but because growers have a choice of market channels and the requirements to enter each channel are different, all three channels will discussed.

The processing market channel

Processors either freeze or can fresh produce to extend its shelf life. The processing sector in the U.S. is characterized by many small firms and a few large firms with several processing plants. Typically processors buy within a 50-mile radius of their plants and contract a high percentage of the acreage before planting time. For example, in Wisconsin the contracted acreage can run as much as 80 to 90 percent of the total acreage harvested for processing (Rhodes, 1983).

Although production for year-round consumption via processing could lead to greater acreages for Iowa, the distance to processing plants in Iowa limits the feasibility of processing crop production, at least in the short run. Furthermore, the crop varieties needed for processing can be considerably

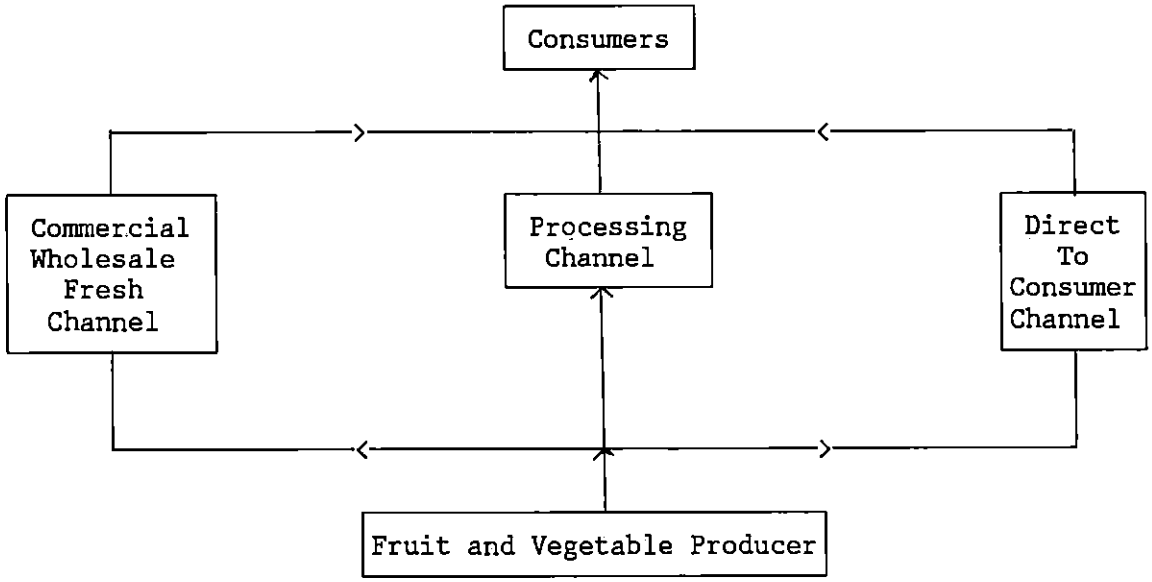

Figure 1. Fruit and Vegetable Marketing Channels

different than those used in the commercial wholesale markets. For example, chipping potatoes are bred to have low soluble sugars so that the chips won't caramelize (brown) during the chipping process. Not all fresh tablestock varieties have that characteristic. Also, the harvesting techniques for processing typically are different from those in the commercial wholesale fresh channel. For example, tomatoes for processing are picked mainly with mechanical harvesters and fresh commercial production is still largely hand-picked, although there has been some movement toward mechanical harvesting of fresh produce (Kader et al., 1985).

The direct-to-consumer market channel

The direct-to-consumer channel is another primary market outlet. There are several marketing methods in this channel, including the pick-your-owns (u-picks), roadside stands, and the farmers' markets. In direct-to-consumer markets the producer and the consumer bypass all the middlemen in the

commercial wholesale fresh produce channel. Both the consumer and producer benefit because the price is usually between the wholesale price the farmer would normally receive and the retail price the consumer would normally pay.

With u-pick operations, the producer depends on the consumer to pick the produce, saving the grower considerable harvesting and postharvesting costs. The consumer, in return, often gets a lower price and a product closer to maturity that, at least in the consumer's view, is a better quality product. The farmers' markets and roadside stands similarly provide a place for growers to sell directly to the consumer and are fairly similar to one another in their requirements except for their location. Roadside stands are usually close to the producers' operations on busily traveled roads, whereas farmers' markets are located in town centers or in high traffic portions of the city where consumers are likely to pass by while shopping. Both of these marketing methods require a producer to harvest and temporarily store the produce, but do eliminate most of the postharvest-handling middlemen. These markets also allow the producer to receive a price that can approach or exceed the retail price. A considerable amount of Iowa's produce appears to be sold in either u-picks or roadside markets. Iowa's farmers' markets are in various stages of development in the major cities and are gradually becoming more prevalent in the smaller towns.

One of the difficulties with studying the feasibility of expanding production in the direct-to-consumer market is the lack of available data. Of the three major market channels discussed, the direct-to-consumer channel has less price and quantity information available than any other channel. The United States Department of Agriculture (USDA) collects data on planting intentions for a limited number of fresh and processing vegetables. Marketing data such as fresh wholesale market arrivals (quantities) and wholesale prices

are only collected in a few cities in the United States. These wholesale price and quantity data do not necessarily include or reflect direct-to-consumer marketing prices or quantities. Shipments and shipping prices are collected only in the most prominent shipping states. These data primarily cover produce moving in the processing and commercial wholesale sectors. The acreage data associated with the commercial wholesale fresh channel are sketchy in states that have small production acreages, but, in general, the data are sufficient for the purposes of this study.

The commercial wholesale fresh market channel

The commercial wholesale fresh produce marketing channel is diagrammed in Figure 2. There are five basic levels to the market channel. Produce does not move in any particular set way from the grower to the consumer. The driving force at the top of the channel is the consumer. Just beneath the consumers are the retail outlets and institutional outlets. The retail outlets primarily consist of supermarket chains (including national, regional and local chains) and local grocery stores. The local grocery stores can be loosely allied for bargaining advantages or they can be totally independent. Institutional buyers include hospital cafeterias and food service outlets such as restaurants and fast-food chains. Fast-food chains are important fresh produce outlets inasmuch as they have instituted salad bars in recent years to please health-conscious consumers.

At the next level in the channel are the terminal markets and the wholesaler-retailers. Terminal markets usually are associated with large cities where fresh produce has come to the end of the marketing chain in a region. From the terminal market, the produce is dispersed to either the grocery stores or the institutional outlets within the region. Terminal

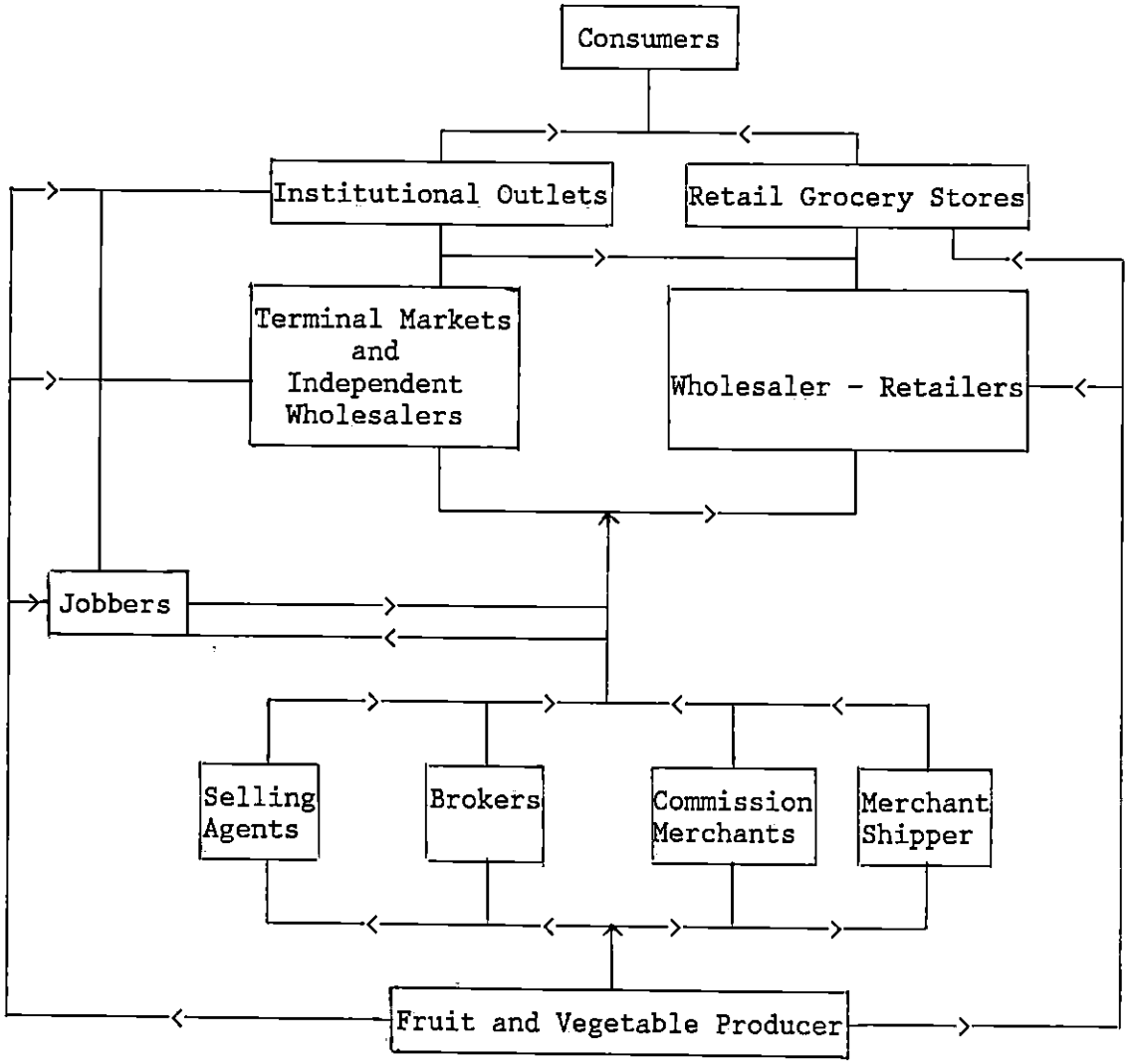

Figure 2. The Commercial Wholesale Fresh Fruit and Vegetable Channel
Information from Vitelli et al. (1982)

markets are characterized by a large number of merchants who are organized together into a centralized assembly and selling area. Although the terminal market used to be the major distribution center for fresh produce, it has declined in importance in the last 30 years, though this decline has stabilized recently. Besides the terminal market merchants in an area, there may be a number of independent wholesalers who take possession and title and resell produce to their customers, especially in areas where the terminal market no longer exists. Inasmuch as Iowa has no terminal markets, independent wholesalers and wholesale-retailers are the main wholesale outlets within the state.

The wholesaler-retailers are large retail chain stores that have centralized wholesaling and distributing for the entire chain. They also may be the wholesaler for other chain stores. The wholesaler portion of the chain accepts orders from the individual units of the chains and organizes the buying for the quantities ordered. But the organization of wholesaler-retailer units differ. Some chains force their individual units to buy from their main wholesaling unit; others allow their units to buy from other sources. Thus, producers may find that it is possible to sell either to the individual local stores or the centralized purchasing unit.

At the next lower level, and declining in importance to the industry in the share of produce they handle, are other middlemen such as selling agents, brokers, commission merchants, and merchant shippers. These middlemen usually perform functions that facilitate ease of movement of different fresh produce items. For example, small producers may want a selling agent, working on a contractual basis to sell their output. The selling agent may have some degree of freedom in pricing the produce but never takes title or possession of the produce. Jobbers could fit in this category or between levels. The

jobber fills in the gaps that are missed by all the other facilitators. The jobber usually buys produce with a specific outlet in mind, sorts and repacks the produce to fit the needs of a particular institution. They may sell and buy from anyone in the chain.

The broker also performs nearly the same duties as the selling agent, but brokers are not under contract and never take possession or own the produce. They simply bargain for the highest price and take a percentage of the sales as commission.

The commission merchant works a little closer with the producer than either the selling agent or the broker. The commission merchant has facilities for handling, packing, pricing, and selling the produce. The commission merchant takes possession but not title of the produce and receives instructions from the producer on when or how to sell. Similar to the commission merchant, the merchant shipper has facilities for packing, handling, pricing, and selling but the merchant shipper takes title and possession of the produce.

There is no standard pattern in which produce moves from the grower to consumer. Some pertinent statistics indicate how the produce flows from the producer to the consumer. Most of the fresh produce, 76 percent, is sold through retail grocery stores, another 22 percent is sold through the institutional outlets such as the restaurants, hospital cafeterias, and fast-food outlets. The remaining 2 percent is sold in the direct-to-consumer market (McLaughlin and Pierson, 1983). Chain stores represent 65 to 100 percent of the retail grocery trade in the midwestern region (Spotton et al., 1986). If their total retail share is similar to their share of fresh produce sales, the wholesaler-retailers sell the major share of the wholesale fresh produce in the upper Midwest (Spotton et al., 1986).

The wholesaler-retailer appears to be the major recipient of fresh produce. But what path does it take to arrive at the wholesaler-retailer? Evidence indicates that the produce moves primarily to the wholesaler-retailer directly from the grower-shipper. The grower-shipper produces the fruits and vegetables and ships directly to the wholesaler-retailer or directly to the grocery store by-passing all the middlemen. The industry term for this is direct-marketing (not to be confused with direct-to-consumer marketing).

This portion of the trade has increased dramatically in the past years, as evidenced both by the sales statistics and by the decline in the number of terminal markets (Rhodes, 1983). Further evidence was provided by an Iowa State University survey (Spotton et al., 1986) in four major metropolitan areas. The major wholesaler-retailers in the areas were buying most commodities directly from the shipper, and they implied that those shippers were also usually the growers. In addition, the buyers indicated that they only purchased from the terminal markets when a shipment did not arrive or they found themselves short of produce from other resources.

The direct-marketing scheme is not dominant for all wholesaler-retailers in some crops. For example, tomatoes and potatoes tend to be purchased from jobbers or repackers. The repacker may sort tomatoes according to maturity, continue the ripening process for those still too immature to sell, and package those ready for sale. But, some retailers may have their own repacking and ripening facilities and buy the produce directly from the grower.

Requirements for the commercial wholesale fresh produce market

The marketing requirements for selling produce in the commercial wholesale fresh channel are rigid. These marketing requirements include long

shelf-life, ease of handling, and good physical outward appearance for the fresh produce.

The longer the shelf-life of the produce, the more likely it is that the store will be able to sell that produce before it deteriorates. To provide for the long shelf-life required by the industry, the commercial fresh producer must invest in ice or cooling equipment such as a hydrocooler to remove the field heat from the perishable produce and slow its deterioration. In addition, the grower must be able to distinguish between vegetables that are chilling-injury sensitive and those that are not. Produce such as cucumbers, green peppers, and tomatoes are very sensitive to chilling-injury and precise temperature ranges must be adhered to in the cooling process. Crops such as sweet corn and broccoli may be iced. The costs of icing are similar per unit to hydrocooling when the hydrocooler is used at capacity (Junge et al., 1985). Thus, to remove field heat and provide a long shelf-life, $.01 to $.02 per pound must be added to the overall produce cost.

Buyers want the produce to be packed in boxes that are sturdy enough to be transported in stacks four boxes high on pallets to promote ease of handling. The cost of the ideally sized box is usually $.80 to $1.00 and adds considerably to the cost of the produce (Junge et al., 1985).

Because the appearance of the produce is as important to the wholesaler as it is to the consumer, the commercial wholesale producer must invest a considerable amount of time in sorting and sizing the produce. Uniformity as well as the lack of bruises and nicks is important to the overall appearance of the produce.

There are other requirements to compete in the commercial wholesale channel. The supplier not only must be a reliable source in the quality of the produce sold but must also remain in the market week after week. The

producer who is in the market one week and out the next will not continue to sell in the wholesale channel for long. Wholesalers need to provide their customers with a stable produce supply and, therefore, require the same stability from their suppliers (Spotton et al, 1986). Thus, irrigated acreage would help a producer to meet the reliability requirement. With irrigation the producer is more likely to weather periodic droughts during the summer and provide a dependable steady produce supply.

One last restriction for selling in the wholesale sector is that the grower must sell at only one level of the market chain per region. Wholesalers indicate that they do not like to buy produce from a grower and then find the grower also has sold to the wholesaler's customer. They do not want the grower to set up a roadside stand across from the retail outlet that the wholesaler supplies because they feel they should not compete with their supplier. Thus, growers who participate in the direct-to-consumer markets probably do not enter the commercial wholesale market in the same area. This phenomenon may occur occasionally as long as the grower does not compete too obviously (Spotton et al., 1986).

Determining the suppliers of Iowa's commercial wholesale fresh market

Although Iowa may produce a number of acres of fresh vegetables, most of that production finds its way into the processing and direct-to-consumer markets rather than into the commercial wholesale fresh market. In 1985 the Iowa Department of Agriculture (IDA) surveyed the wholesalers and wholesaler-retailers in Iowa to determine the quantities of produce being bought and from which states they were being bought. The IDA surveyed all the firms in Iowa that could be identified as buyers and sellers of fresh produce in the

commercial wholesale fresh market, but the retail outlets were not surveyed unless they were wholesaler-retailers (Valley, 1985).

Similarly, Iowa State University studied the feasibility of selling fresh fruits and vegetables in the four surrounding metropolitan areas: Chicago, Kansas City, St. Louis, and Minneapolis. As a part of that study the wholesaler-retailers and a sample of independent wholesalers and terminal market wholesalers were interviewed to determine the commercial wholesale fresh market requirements. During those interviews the wholesalers were asked who supplied their produce during Iowa's production season, whether Iowa sold them any produce and, if so, how much, which crop, and whether their buying volumes declined during the peak local growing season.

Iowa's major suppliers and the surrounding state's suppliers according to these two surveys are listed in Table 3, although more states actually were reported to surveyors than are listed. Because of the informal survey method, the two surveys show a different list of suppliers for the surrounding major metropolitan areas and the Iowa market, but there are a number of similarities between the two surveys. Snap beans, cabbage, sweet corn, green peppers, and winter and summer squash were generally supplied by midwestern states but could be bought from California or Florida. Broccoli was almost exclusively supplied by California although some was bought from Texas. Chicago buyers indicated a willingness to purchase local broccoli although buyers in all of the other metropolitan areas surveyed were reluctant to buy from local growers. Few reasons were given for lack of interest in local produce. Tomatoes were purchased mainly from California, but some were purchased from midwestern sources. Some differences in cucumber and watermelon purchases were noted. The IDA survey indicated that most melons were bought from

Table 3. Iowa's Fresh Produce Competitors

Crop	Competing Regions: Iowa Department of Agriculture[a]	Iowa State University[b]
Broccoli	California, Texas	California, Illinois, Michigan, Wisconsin
Snap beans	Michigan, Wisconsin	Florida, Illinois, Indiana, Michigan
Cabbage	California, Illinois, Michigan, Wisconsin	Florida, Illinois, Texas
Sweet corn	California, Florida, Illinois	Illinois, Indiana, Michigan
Cucumbers	California, Florida, Texas	California, Illinois, Indiana, Michigan
Leaf lettuce	California, Florida, Michigan, Wisconsin	California
Muskmelons	Arizona, California, Texas	California, Illinois, Indiana, Michigan
Green peppers	California, Florida, Michigan	California, Illinois, Michigan
Potatoes	Idaho, Wisconsin	California, Idaho, Illinois, Michigan, Wisconsin
Summer squash	California, Florida, Michigan	Illinois, Michigan
Winter squash	California, Michigan	Florida , Michigan, Illinois
Tomatoes	California, Florida, Michigan	California, Illinois, Michigan
Watermelon	California, Florida, Texas	Illinois, Missouri, Texas

[a]Valley (1985).

[b]Spotton et al. (1986)

California, Florida, or Texas, whereas the ISU survey indicated that most were bought from nearby states.

The majority of Iowa wholesalers reported that less than 1 percent of the total produce bought during the summer months was from Iowa producers (Valley, 1985). Their major reason for not buying from Iowa growers was that Iowa produce failed to meet the quality standards of produce that they could buy elsewhere (i.e., the produce failed to meet boxing, cooling, and appearance standards). The Iowa State University survey of nearby metropolitan areas also indicated that very little produce was bought from Iowa. Most buyers reported buying no produce from Iowa and rarely would a buyer indicate that he had received Iowa crops. One buyer mentioned that he had bought muskmelons (cantaloupe) from Iowa, but only for same day delivery to his stores (Spotton et al., 1986).

To properly determine Iowa's competitive position in the Midwest, some estimate of the volume supplied by each competitor is necessary. No data of this type are available for Iowa. However, the USDA reports produce arrivals to the Chicago market, and includes information by commodity in hundredweights (cwts.) for each state supplying wholesalers in the Chicago area. It seems likely that these same competitors supply Iowa in roughly the same proportion as they do Chicago.

By using the Chicago arrivals data as a rough approximation of competing suppliers' market shares,and information on Iowa harvest periods, quantities supplied to the Iowa market for each month are estimated. Each supplying state was assumed to supply Iowa in the same proportion that it supplied Chicago. The proportion of yearly per capita consumption purchased each month was assumed to be similar to the ratio of each month's arrivals to total annual arrivals multiplied by the annual per capita consumption. The

percentage of the monthly markets supplied by each state for each crop are listed in Table 4, along with Iowa's estimated monthly consumption.

The 1984 Chicago arrivals data show that California is the major supplier of broccoli, leaf lettuce, cantaloupe (muskmelons), green peppers, tomatoes, and early potatoes. If local suppliers are defined as including Illinois, Indiana, Michigan, Missouri, and Wisconsin growers, but excluding Iowa (as most buyers in the ISU survey did), the following crops are mainly supplied locally: snap beans, cabbage, sweet corn, cucumbers, summer and winter squash, watermelons, and some green peppers. The southeast-- Florida, and others--provided larger amounts of snap beans, sweet corn, summer and winter squash, and watermelon during the transitional months when local production was just coming on the market. Texas, also a transitional period supplier, was an early-summer supplier of cabbage and watermelons, and a late-summer supplier of cucumbers, green peppers, and watermelons. Transitional periods are in the spring and early-summer season, when local production is just coming on the market, and in the fall when the first killing frost is hitting the upper Midwest and southern states are just beginning fall harvest.

Comparative Production and Marketing Costs

To determine whether Iowa could expand in vegetable production and compete effectively with current suppliers to Iowa and the midwest metropolitan areas, an examination of whether Iowa can produce and market at a lower or equivalent cost to these major competitors must be made. The key factors to be examined are production and transportation costs to midwest markets for Iowa and competing states, consumer demand, and the risk faced by producers in each region. By comparing each competing region's costs, profitability and risks, the states which can most effectively and efficiently supply the

Table 4. Estimates of Competing Regions Share of Iowa Supply and Iowa Consumption, by Crop

Crop/State	Month					
	May	June	July	August	September	October
				(percent)		
Broccoli						
CALIF.		100	90	75	63	61
ILL.			10	25	26	22
MICH.						6
WIS.					11	11
Iowa Consumption (cwt.)		1790	1053	842	2001	1896
Snap beans						
FLA.		33				
GA.		67				50
ILL.			67	50	67	33
N.J.				25		
N.C.						17
TENN.			33	25	33	
Iowa Consumption (cwt.)		856	2568	3424	2568	3424
Cabbage						
CALIF.		3	4			
DEL.		3				
FLA.		3				
ILL.		9	39	42	27	32
IND.			18	13	27	10
KY.			11			
MD.		3				
MICH.			4	4	5	13
MISS.		9				
N.J.		3				3
N.Y.		25	4			3
N.C.		3				
OHIO				4	5	3
TENN.		3				
TEX.		34	7			
WIS.			14	38	36	35
Iowa Consumption (cwt.)		10418	18231	15627	14325	20185

Table 4. (Continued)

Crop/State	May	June	July	August	September	October
			Month			
			(percent)			
Sweet corn						
ALA.			9		5	5
DEL.			3			
FLA.			35			43
GA.			6			5
ILL.			29	83	32	
IND.			3	10	5	
KAN.			3			
MO.			12			
MICH.					11	10
N.Y.					5	19
OHIO					5	10
WIS.				8	37	10
Iowa Consumption (cwt.)			11095	50907	18600	6852
Cucumbers						
FLA.			4			16
GA.						25
ILL.			21	33	15	6
IND.			7	13	15	
MICH.			14	33	38	6
N.J.					8	
N.C.			43	20	15	16
OHIO			4			
S.C.						13
TENN.			4			
TEX.						16
VA.			4		8	3
Iowa Consumption (cwt.)			7123	7632	6614	5427
Leaf lettuce						
CALIF.	100	83	71	57	57	71
OHIO		17	29	43	43	29
Iowa Consumption (cwt.)	490	981	1144	1144	1144	1144
Muskmelons						
ARIZ.			87	96	96	83
CALIF.			9	1		17
GA.			1			
ILL.				2	3	
IND.			2	1		
N.J.			1			
TEX.			1	1	1	
Iowa Consumption (cwt.)			34764	53945	29170	3862

Table 4. (Continued)

Crop/State	Month					
	May	June	July	August	September	October
				(percent)		
Green peppers						
CALIF.			6	23	33	37
FLA.			6			5
GA.			28			
ILL.			6	46	33	26
IND.				8	11	
LA.			11			
MICH.				8	22	5
N.C.			39	15		
TEX.			6			26
Iowa Consumption (cwt.)			5223	7545	5223	3676
Potatoes						
ALA.			3			
ARIZ.			2			
CALIF.			57	6		0
COLO.					1	1
IDAHO			12	3	13	21
ILL.				3	02	2
IND.						1
MICH.			0			3
MINN.				19	14	13
NEB.						0
N.D.					1	4
N.M.				1		
OKLA.			0			
ORE.				2	8	2
TEX.			21	17	2	
VA.			0	0		
WASH.			1	15	4	2
WIS.			3	33	56	50
Iowa Consumption (cwt.)			56763	139395	94367	116881
Summer squash						
FLA.						14
GA.		33			17	14
ILL.		67	60	50	50	43
IND.					17	14
MICH.			40	50	17	14
Iowa Consumption (cwt.)		304	1015	812	1218	474
Winter squash						
FLA.						14
GA.					17	14
ILL.					50	43
IND.					17	14
MICH.					17	14
Iowa Consumption (cwt.)					573	669

Table 4. (Continued)

Crop/State	Month					
	May	June	July	August	September	October
				(percent)		
Tomatoes						
ALA.			1			
ARK.			1			
CALIF.			69			
FLA.			4	44	55	90
GA.			4			6
ILL.			5	15	5	
IND.				3	2	
KY.			2	2		
MICH.				18	17	1
OHIO			2	16	21	02
PA.				2		
S.C.			8			
TEX.			1			
VA.			1	2		
MEXICO			2			1
Iowa Consumption (cwt.)			24052	30125	20408	14253
Watermelons						
ARK.				1		
FLA.			23			25
GA.			44		3	
ILL.				9	41	13
IND.			1	32	13	
IOWA				3		
MISS.			1			
MO.			18	54	28	13
N.C			1			
TEX.			12	2	16	50
Iowa Consumption (cwt.)			27200	92160	15360	1280

Source: USDA, Chicago Fresh Fruit and Vegetable Wholesale Market Prices, 1984.

midwest markets can be determined. To accomplish this task, a mathematical programming model was developed to consider the relative competitive costs of producing vegetables and more traditional crops in Iowa versus producing vegetables in competing regions. The model determined the prices and quantities of vegetables delivered to Iowa markets by Iowa producers and other competing states' producers so that the market had no excess supplies or demands.

Standard methods were used to incorporate upward sloping cost curves and downward sloping demand curves to determine the prices that would clear the market (Figure 3). These techniques are critical to a successful analysis where the introduction of new production may cause lower market prices due to increased output. As detailed in Figure 3, the addition of new production (the dashed line) tends to lower the price that will clear the market from P_0 to P_1. Whether the new lower price will sustain a profit is important to new vegetable producers. A similar approach has been used by agricultural policy researchers (Norton and Solis, 1983) to analyze vegetable production in Mexico.

Iowa's production and transportation costs are compared to competing states' costs to produce and to reach the Iowa market. These constant cost supply curves are adjusted for both market and production risk and, thus, become upward sloping like the ones shown in Figure 3. By accounting for the extent that gross revenues change from year to year, both price and yield risk can be included in the analysis. Assuming operators prefer less risk to more (are risk averse), the more variable gross revenues are per unit of profit, the less willing operators are to produce that crop. Thus, by associating increased variability in revenues with increased production cost, growers are

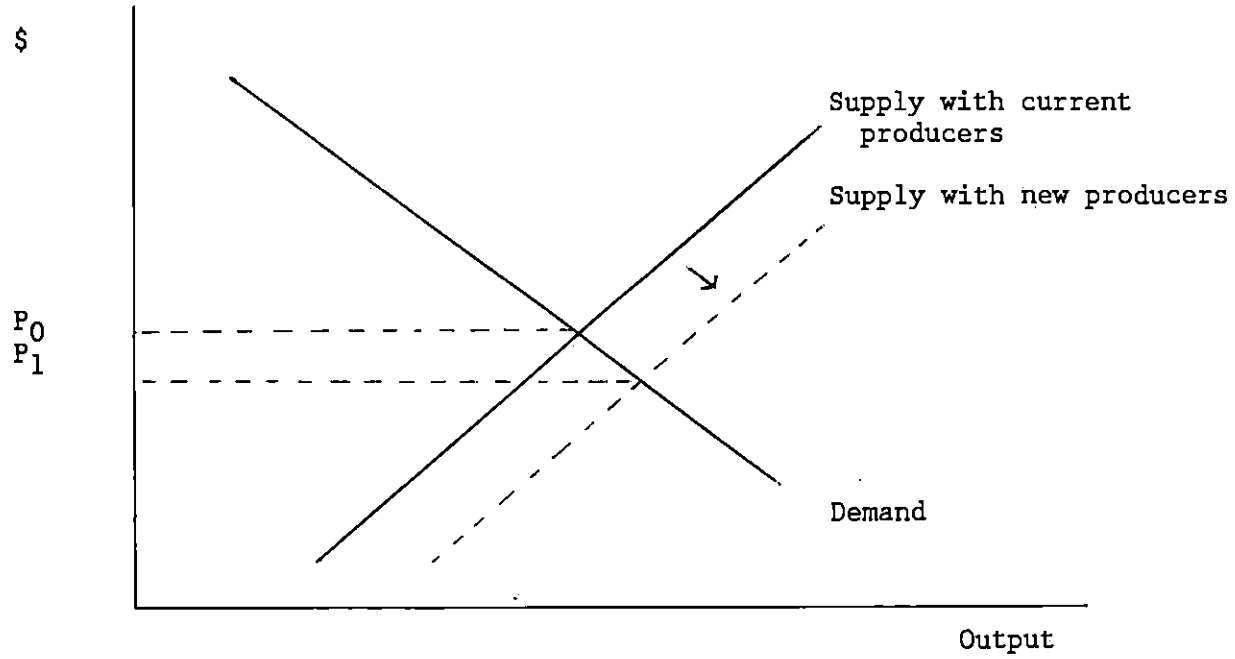

Figure 3. Competitive Equilibrium Before and After a New Area Starts Producing Vegetables

less willing to produce a crop with greater variability in revenues given a certain level of profit (Anderson et al., 1977).

Hazell and Scandizzo's (1974) approach to incorporating variability in revenue into the analysis was used. Deviations from average revenue increase with increased production as shown in Figure 4, panel a. These authors demonstrate that deviations from average revenue have a direct relationship to variability in revenue as shown in 4b. They also show that because variance increases at an increasing rate as production increases, the constant cost supply curves adjusted for risk slope upward to the right as in panel c of Figure 4.

The demand curves or wholesale price-quantity relationships for the vegetables were modeled using techniques similar to Duloy and Norton (1975). Demand relationships were based upon Chicago prices and estimations of price responsiveness in that market. The intersection of the supply curves and

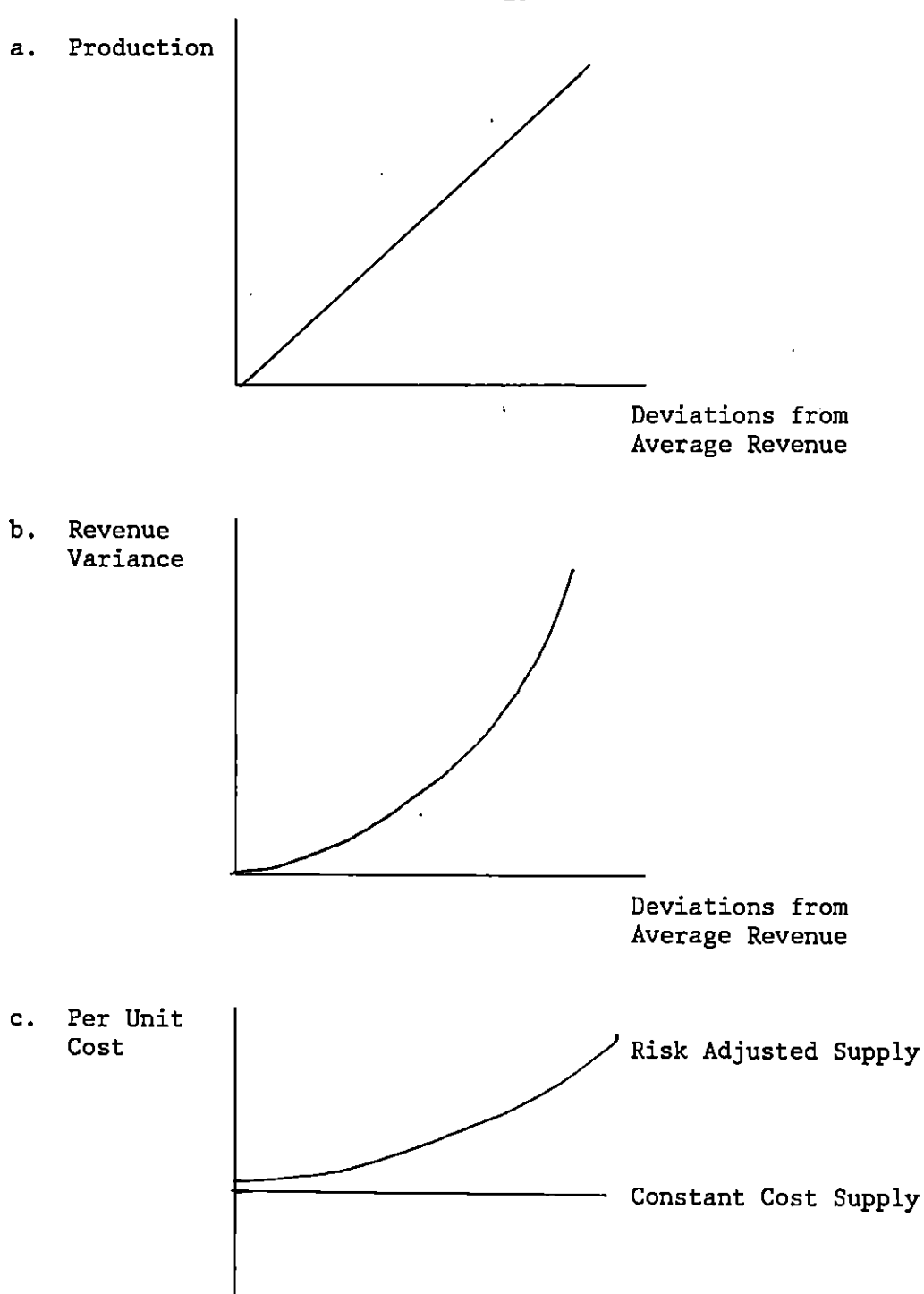

Figure 4. Adjusting Supply Curves for Risk

demand curves determines the equilibrium prices and quantities of vegetables supplied to the Iowa market for each state involved as shown in Figure 3. (For more details on the actual modeling procedure, see Weimar, 1986).

Once the model had been developed, it was used to analyze production and marketing for the Iowa market. Because of the data estimation methods used, steps were taken to determine how sensitive the results were to changes from the most likely scenario. Yields were increased and decreased to simulate possible differences in Iowa cost estimates. Furthermore, because rising transportation costs were thought to be a leading cause of shifts in the cost advantage, the effect of possible changes in fuel costs were studied. Lastly, because Iowa's horticultural hourly wage is lower than the major producing areas, Iowa's hourly wage level was doubled and the results were examined.

The next sections explain and describe the data and sources that were used to obtain the results from the model. The results and analysis of them follow the data description.

Iowa vegetable production costs

Because production cost estimates for any fruit or vegetable being produced within the state of Iowa were not generally available, representative Iowa production costs were estimated for this study. Five steps were involved in estimating the representative crop-production budgets. First, northern states' budgets served as a basis for developing initial budget estimates for Iowa. Second, with the cooperation of the Iowa State Extension Horticulturist, these budgets were modified through a cost engineering method to reflect the basic cultural practices used in Iowa. Third, irrigation was added, although it is not a common practice among Iowans, because in some instances it would reduce yield risk and increase quality (both are probably

necessary to successfully supply commercial markets). Yields were adjusted to reflect the irrigation. Fourth, these intermediate budgets were reviewed by five growers in the state to determine their validity and provide final technical input-output, price, and cost adjustments. Fifth, all the information was collected into a final budget form and the results were used in analyzing the problem. Abbreviated versions of some of those budgets are shown in Table 5. The Iowa budgets and the budgeting process are discussed more fully in Appendix A of Weimar (1986).

Competing states' budgets

Some differences between published budgets for the northern states' and the California and Florida budgets can be accounted for by cultural practice differences, but not all states report harvest costs, fixed costs, overhead, marketing, and management. To ensure that the budgets from each state were comparable, some assumptions were made and the missing data were estimated. For example, harvest costs on a per unit basis were assumed to be the same. For states that had harvest costs, including cartons and cooling, the costs were similar. Most states did not publish yearly budgets, so some budgets needed to be updated using the Agricultural Prices Summary (USDA, 1973-1984) "Prices Paid Index." Individual items were updated by using the price index that most closely fit the item. For example, seed costs were updated using the seed price index, fertilizer costs were updated by the fertilizer price index, and so on. Thus, all budgets were estimated for the 1984 crop year.

Iowa and competing states' transportation costs

Transportation costs for other states were obtained from the USDA truck rate and cost summary (USDA, 1985) and Iowa's within-state transportation

Table 5. Representative 1984 Iowa vegetable budgets for one acre

Crop	Quantity	Units	Price Per Unit	Total
Broccoli				
Total Revenue	5000	Lbs.	$ .41	$2050.00
Preharvest Variable Costs				
Land Preparation				14.96
Fertilization				88.06
Plants	8300	Plants	.32	265.60
Planting				54.00
Pesticides				39.41
Cultivation				81.68
Irrigation				12.24
Interest				35.94
Total preharvest variable costs				**588.82**
Harvest Costs				
Labor	70.00	hours	5.00	350.00
Grading	7.00	hours	5.00	35.00
Hauling				4.54
Ice	2.27	tons	43.05	97.73
Cartons	227.27	cartons	.86	195.45
Total Harvest Costs				**682.72**
Total Ownership Costs				**300.23**
Total Costs				**1571.77**
Returns over Variable Costs				**778.46**
Returns to Unpaid Factors				**478.23**

Table 5. (Continued)

Crop	Quantity	Units	Price Per Unit	Total
Sweet Corn				
Total Revenue	1000	doz. ears	$1.25	**$1250.00**
Preharvest Variable Costs				
Land Preparation				8.12
Fertilization				93.83
Seed	8.00	lbs.	3.09	24.72
Planting				4.76
Pesticides				49.37
Cultivation				7.61
Irrigation				18.36
Interest				13.44
Total preharvest variable costs				**220.20**
Harvest Costs				
Labor	48.00	hours	5.00	240.00
Grading	4.80	hours	5.00	24.00
Hauling				4.54
Ice	200.00	cartons	.79	158.00
Cartons	227.27	cartons	.86	194.00
Other				2.20
Total Harvest Costs				**620.54**
Total Ownership Costs				**347.76**
Total Costs				**1188.50**
Returns over Variable Costs				**409.26**
Returns to Unpaid Factors				**61.50**

Table 5. (Continued)

Crop	Quantity	Units	Price Per Unit	Total
Green Pepper				
Total Revenue	300	bu.	$9.55	**$2865.00**
Preharvest Variable Costs				
Land Preparation				14.96
Fertilization				74.09
Seed	7200	plants	.027	193.68
Planting				101.77
Pesticides				93.46
Cultivation				66.68
Irrigation				20.60
Interest				37.39
Total preharvest variable costs				**612.62**
Harvest Costs				
Labor	50.00	hours	5.00	250.00
Grading	9.50	hours	5.00	47.50
Hauling				4.54
Cooling	300.00	cartons	1.41	258.00
Cartons	300.00	cartons	.86	423.90
Total Harvest Costs				**983.94**
Total Ownership Costs				**296.56**
Total Costs				**1893.12**
Returns over Variable Costs				**1268.44**
Returns to Unpaid Factors				**971.88**

costs were obtained by personal phone contacts with Iowa trucking firms. Iowa's within-state costs were not much different from those obtained from the USDA sources for Michigan to Chicago, approximately $3.30 per mile.

Competing state transportation rates to Iowa were not available from USDA so estimated costs for shipments to Chicago from various states were adjusted to reflect the distance to Iowa rather than to Chicago. In addition, because the net weight of fresh vegetables carried per truckload differs from crop to crop, the cost of transporting each vegetable was adjusted to reflect weight-to-volume differences.

Price-quantity relationships

Price-quantity relationships were needed to determine how much prices would change when local production increased. Iowa demand functions were calculated based on prior estimates of Chicago-area demand relationships for 1972-76. These demand relationships obtained from the University of Georgia (Epperson et al., 1981) for Chicago were similar to their estimates for other cities, so midwestern price responsiveness estimates should be similar to estimates for Chicago. The best procedure to obtain the demand relationships would have been to reestimate these demand functions. Unfortunately, the functions could not be updated because the original data was discontinued in August 1976. Hence, these were the newest estimates of demand for fresh vegetables available that cover the six marketing months investigated in this study.

Per capita consumption

No USDA estimates were available for 1984 per capita consumption at the time the study was initiated. Yearly per-capita consumption for 1984 was

estimated from trend analysis of USDA data from USDA Food Consumption, Prices, and Expenditures, 1983 covering 1962-1983. For a more complete discussion of estimation methods see Appendix C of Weimar (1986).

Price and yield variability

Price and yield (revenue) variability is important information to both producers and buyers. Revenue variability could be a good indicator of the variability of net profits associated with each crop and would be important to the growers' decision-making process. Buyers could be equally interested in how variable their supply would be if they had to depend on a single region for produce.

Yearly vegetable revenue data for all the competing regions were collected from two USDA publications, Agricultural Statistics (USDA, 1961-1982) and Vegetables Annual Summary (USDA, 1961-1982). The information was compiled into gross revenue figures by state and a seasonal gross revenue was used where possible for each month's harvested production in some states.

In the North Central region yields were not reported consistently over time for each state, so estimates of gross revenue for each state were estimated by using the closest state that had a complete gross revenue time series for a particular crop. As a consequence, Michigan, Iowa, Illinois, and Missouri have similar revenue variable estimates. To account for inflation in the time series, the data were multiplied by the "Prices Received By Farmers index" found in Agricultural Prices Summary (USDA, 1961-1982) and then a time series of deviations from average revenue was calculated for each vegetable to provide a measure of risk to the producer.

Land availability

Land is not a limiting factor for Iowa self-sufficiency in the production of fresh horticultural crops. Iowa's approximately 149,358 acres of peat and muck soils, 722,377 acres of sandy and sandy loam soils and 6,200,802 acres of silt and silt loam soils are more than double the total acres used for production of 22 major fresh vegetables, melons and potatoes in the entire United States for 1981 (Hall, 1985, Vegetables Annual Summary, 1982).

Analysis

The background information and data were analyzed to determine Iowa's cost competitiveness for the 13 vegetables in this study: broccoli, snap beans, cabbage, sweet corn, cucumbers, leaf lettuce, muskmelon, green peppers, summer and winter squash, tomatoes, and watermelon. Iowa's production and transportation costs to midwestern markets were compared to the competing states production and transportation costs to those same markets to determine if Iowa could supplant competitors in the midwest market for these vegetables. By using the estimated price-quantity relationships for these vegetables, the extent that market prices will be affected by possible supply changes was considered in determining optimum acreage changes. Production risks by region were included in the study to determine if the variability of yield and price would affect who supplied the market.

In addition to determining whether Iowa could substitute its vegetable production for that of its competitors at a lower cost, the sensitivity of these results to changes in Iowa's estimated production costs, fuel costs, and wage rates was examined. Because some estimates of production costs could be inaccurate, yields were decreased and increased in 10-percent increments to determine if errors in estimates of cost per cwt. would affect the results.

Transportation costs are a large portion of the produces' value at the wholesale market level, so changes in cost due to energy price increases or decreases were examined. Because energy costs are approximately 15-20 percent of trucking costs, rising or falling diesel costs may change the least cost area of production. Fuel costs were changed in 10 percent increments to explore the possible resulting changes. Iowa has a relatively low wage rate because there are no unions within the state for produce pickers. To account for possible changes in this situation, Iowa labor costs were changed in 10 percent units and the results were examined.

Results

The results indicate that there are some opportunities for Iowa to replace its current competitors in the commercial wholesale market. Iowa appears to have the competitive edge in producing broccoli, snap beans, cucumbers, muskmelons, potatoes, summer and winter squash, and tomatoes. Tests of cost estimation error indicated that relatively large increases in Iowa's costs could occur without changing the conclusions for most of these crops. Only broccoli and potatoes seemed to be sensitive to small increases in Iowa's cost estimates; small reductions in Iowa's costs made her competitive in the remaining crops. Scenarios with either rising or falling energy costs did not change the primary conclusions of competitive advantage for Iowa. Very large increases and decreases in costs or yields were necessary to change the conclusions.

In the following sections the results are summarized by crop, indicating the regions that predominantly supply the particular crop to Iowa, whether Iowa has the lowest total production and transportation costs, and how much cost estimates could vary while maintaining the same suppliers. For certain

crops risk data were not available; for these crops, the analysis suggests who is the least-cost producer without adjusting for risk. The impact of labor and transportation costs changes are indicated. The results are contrasted with recent marketing studies completed by Iowa State University (Spotton et al., 1986) and the Iowa Department of Agriculture (Valley, 1985) regarding qualitative restrictions on local production.

The potential for expanding vegetable production in Iowa will be outlined under three scenarios: one that assumes no commercial fresh production is occurring in Iowa, one that assumes production is occurring as estimated by the 1982 Census of Agriculture vegetable acres (U.S. Department of Commerce, 1984), and one that assumes production is occurring as estimated by the 1985 ISU horticulture department data (Hall, 1985). The first scenario indicates the number of acres for which Iowa has the competitive advantage if there were no current commercial producers in Iowa. The other two scenarios provide benchmarks against which a minimum potential for expansion can be defined.

Broccoli

The market for broccoli is dominated by California. In the Chicago market, Illinois producers were capturing approximately 25 percent of that market throughout the summer season. Unfortunately, no budgets on broccoli were available from Illinois, Wisconsin, or Michigan, so the analysis was based on California's and Iowa's production costs. Because California had the only complete revenue time series for the broccoli crop, the broccoli analysis examined cost competition between California and Iowa and did not include risk.

The results indicate that Iowa's has a cost advantage in broccoli production, but that a 10-percent increase in Iowa's estimated cost would allow

California to become the lowest cost competitor. Small errors in the cost estimation process would give California the cost advantage.

Market survey results showed that commercial wholesale buyers in the Midwest preferred the California broccoli to midwestern-grown broccoli. Chicago-area market buyers did indicate a willingness to buy midwestern-grown broccoli, but only if it was properly precooled and packed in standardized boxes. The main reason stated for the reluctance to buy midwestern-grown broccoli was that California growers tended to be more honest about the quality of the crop and the uniformity of their pack was better than what buyers had experienced with midwestern growers. The buyers thought the Midwest had a lower quality crop partly due to the lack of precooling, which enhances the crop's shelf life. There is, however, at least one instance where an Iowa farmer is supplying the commercial wholesale market with fresh broccoli that is not precooled but has been stored in a cooler. Thus, knowledge of the market niche's requirements may allow local growers to meet buyer demands with less than a standard cooled pack. One of the major problems that farmers will have to overcome in Iowa is staying in the market for the duration of the local season. Broccoli quality drops as summer temperatures increase. According to the Chicago arrivals data, consumption of the crop generally drops in August, the hottest summer month, probably because of the lower quality crop on the market from all sources.

Snap beans

The proportion of the total quantity of snap beans currently produced by local states is high once production starts in the northern region. Early production takes place in Florida and Georgia and late production in Georgia and North Carolina, but the main season is supplied by local states such as

Illinois. The local supplier market share varied from 75 to 100 percent for the peak summer season production. Thus, snap beans seem to be one crop that has a strong potential to be grown in-state. The analysis indicated that this was true. Separately changing production, fuel, and labor costs all gave results that implied that Iowa's advantage in snap beans would not be lost even with significant relative cost increases.

During the ISU buyer survey interviews (Spotton et al., 1986), snap beans were listed as an item that is almost always purchased locally once the season starts. The only restriction buyers indicated was that the snap beans be handpicked rather than machine-picked. They thought that snap beans did not have a long shelf life when machine-picked. They also stated that the machines caused bruising of the bean, browning the bean and making it less salable. They preferred and were willing to pay a higher price for handpicked snap beans. The evidence indicates a good potential for increased production of snap beans for the local commercial wholesale market.

Cabbage

Cabbage is a crop with many early or transitional-period suppliers to Iowa and midwestern markets. Large early suppliers are Ohio and Texas, with smaller competitors being California, Florida, Illinois and Texas. As the local crop comes into production, Illinois, Michigan, and Wisconsin become the major suppliers.

The analysis indicates that the midwestern states have a cost advantage in fresh cabbage production only when risk is included in the analysis. Iowa would replace supplies from Ohio and the other states in the early and late transitional market periods but the quantities are very small. A 10-percent increase in Iowa's yield would make Iowa cost-competitive with the other

midwestern states. But the cabbage market has been saturated for the last few years and price has been substantially below long-run production costs. Nineteen eighty-six was the first year in which a profit was obtained. Consequently, growers should know that cabbage is a market that is very price-responsive to increases and decreases in production. On the other hand, cabbage may be used as a loss-leader by some growers as a method to entice buyers to purchase other items they produce and it would not be as necessary to make a profit on cabbage if they make a profit on other produce.

The source of cabbage supplies was affected more by fuel cost increases than were most other crops but was similar to other crops in the lack of response to increased labor costs in Iowa. A 20-percent increase in fuel costs was necessary to make Iowa competitive with the other midwestern states in all market periods except October, when a 30-percent rise was necessary before Iowa became the least-cost producer.

Sweet corn

Sweet corn is another crop for which a considerable portion of Chicago demand was supplied by local producers. Over one-half of the production was supplied by Illinois, with the rest being supplied by New York, Florida, and Georgia. Illinois supplied 100 percent of the August demand and 89 percent of the September demand. New York, Ohio, Florida, and Georgia supply a portion of the late summer production, except that Florida production first comes onto the market in October. The demand for sweet corn appears to be very seasonal according to the USDA arrivals data. The quantity consumed rises during July, peaks in August, and falls through the rest of the season. August sweet-corn arrivals were greater than all the rest of the summer harvest period arrivals added together. This study indicates that Iowa is a residual supplier

inasmuch as Illinois and Ohio supplied all but a small portion of the Iowa market. The results are fairly stable; a 20 percent increase in Iowa's costs was necessary to bring in different states as suppliers to the Iowa market. On the other hand, only a 10 percent increase in Iowa's yield, to just 1100 dozen ears, would remove Illinois from competition in this market. Fuel and labor-cost increases did not affect the results.

These results do not appear on the surface to be consistent with the current significant sweet corn production in Iowa. Two different explanations for this apparent contradiction are immediately obvious. First, local retail buyers may be willing to buy fresh sweetcorn that has not been precooled on a day-to-day basis from local growers. Without precooling costs Iowa production would be considerably less costly than sweet corn produced in the other midwestern states, and local growers could compete effectively. This could account for large amounts of production shown in Table 2. Second, the per capita consumption figures used in this study to determine the quantity demanded in Iowa may largely ignore the grower-direct-to-consumer and grower-direct-to-retailer consumption because most production data is collected only in major shipping areas and, thus, ignores production in local markets. The actual explanation may be a mix of both of these reasons.

Cucumbers

Cucumbers are supplied to the Iowa market by Florida and North Carolina in the early market periods and again during the October transitional market period. Georgia supplies the October market and Texas supplies cucumbers in September. Illinois is the major supplier of cucumbers, producing at least 50 percent of the cucumbers marketed, except during October, when it drops to 13 percent share of the monthly market. This latter figure may reflect the

portion of the month before frost kills the vines--Illinois still may be the major supplier to the Chicago market during the earlier part of October. Due to the high sensitivity of cucumbers to frost, there will be years in which no midwest production occurs in October because frost will have occurred before October.

Our analysis suggests that cucumbers could be produced by Iowa with expectations of enormous returns for growers, and Iowa growers would produce large quantities of them. Large increases in Iowa's cucumber production costs did not change the conclusions to this study. A 40 percent increase was necessary before there was any change in the results. Likewise, a 100-percent increase in the labor costs did not change the results. But, the estimates of price declines associated with these quantity changes are probably too conservative. It seems that such quantity increases would likely have a pronounced impact on local market prices, and such extreme increases would not be feasible without destroying profitability.

Leaf lettuce

Approximately 40 acres of leaf lettuce are required to meet Iowa's demand at current prices. A competitive analysis was not feasible because budgets for California, the major producer, could not be obtained.

Muskmelons

Muskmelons are primarily supplied by California in all market periods, with local producers capturing 2 to 4 percent of the market during August and September according to the Chicago arrivals data. Muskmelons are a crop with a seasonal demand; production rises during July, peaks in August, and falls during the rest of the market season according to the Chicago arrivals data.

Total local production to the Chicago market actually peaks during July and remains fairly even throughout the rest of the market periods. Ohio is the only supplier other than Illinois, Indiana, Michigan, and California.

The results indicated that Iowa is the least-cost producer of muskmelons. Those conclusions remain true with a 10-percent increase in production costs. At 20 percent, Illinois, Indiana, and Michigan production enter the results. With a 50-percent increase in Iowa's estimated costs, California and Ohio become the primary suppliers. Thus, the analysis indicates that costs or yields could be considerably underestimated and the conclusions would still remain the same. Changing fuel costs and Iowa's labor costs had no effect on the result.

These results must be qualified, however, by conclusions drawn from the Iowa State University survey (Spotton et al., 1986). California currently supplies a considerable portion of the muskmelon market. In the industry, buyers refer to California muskmelons as cantaloupe and midwestern or eastern muskmelons as muskmelons. This distinction between the areas indicates that a quality difference is perceived by these buyers. In fact, there is a difference. California muskmelon is smaller than the midwestern melon and has a longer shelf-life even when both are cooled. Midwestern wholesale buyers have indicated a reluctance to buy midwestern melons in any larger portion of the market without precooling, but did indicate they were willing to increase purchases if the crop was properly precooled, even though it still has a shorter shelf-life than the California muskmelon.

Green peppers

Green peppers are supplied in the early summer transitional market periods by California, Texas, Florida, Georgia, and North Carolina. Local

production by Illinois and Michigan accounts for more than 60 percent of consumption during August and September, and they supply one-third of the market in October. The fact that they supply only 6 percent of the July market may reflect the portion the month during which they are able to produce.

The results of this study indicated that Iowa would only be a residual supplier of green peppers. Illinois, Michigan, Florida, and Georgia had lower costs of production than Iowa and supplied the greatest portion of the green pepper market. An increase of 30 percent in the yield to about 113 cwt. per acre would be necessary for Iowa to compete in the early markets. But to remove Illinois from competition during the main season, a yield of about 122 cwt. per acre was necessary. On the other hand, to remove Iowa as a residual supplier would require a 40-percent increase in costs. The green pepper results were unaffected by rises in fuel costs or Iowa labor costs. Because the green pepper results were insensitive to all but large cost changes, the quantities that could be supplied by Iowa should be fairly stable over time. Local buyers showed no reluctance to buy green peppers and USDA arrivals to the Chicago market indicate that green peppers are being bought from local producers, so local producers should not meet any resistance in their marketing efforts.

Potatoes

Potatoes were supplied in the early transitional market periods by the Southwest U.S.; Idaho, Michigan, Washington, and Wisconsin supply some of the market during these periods but do not become large suppliers until August, when they are joined by North Dakota and Minnesota. Wisconsin becomes the largest single supplier to the Chicago market in August. The Iowa Department

of Agriculture survey indicates a similar list of suppliers to the Iowa wholesale market.

The analysis indicates that Iowa has a cost advantage in the production of potatoes, but small changes in either yields or production costs could change the results. Both Idaho and Michigan would be suppliers with a 10 percent increase in Iowa's costs. However, a 30-percent increase in costs was necessary to bring Wisconsin, normally a large supplier, into the market based on the yield and cost estimates available. With a 50-percent increase in Iowa's costs, California would become competitive in our analysis. In addition, the potato-supplying regions were relatively unresponsive to rises in Iowa's labor costs. Potato suppliers did not change until a 100-percent increase in Iowa's labor costs were incurred. Washington then entered the market in all market periods.

Midwestern buyers indicated little resistance to buying locally produced potatoes. But the ISU survey noted that some buyers were reluctant to buy directly from growers (Spotton et al., 1986). These buyers indicated they bought their potatoes from a repacker who sorted and repacked the potatoes to meet the buyers specifications. This is another instance where it is necessary for the grower to satisfy the buyer's specification to achieve successful market entry.

Summer and winter squash

Squash is a vegetable with extraordinarily little market or production cost data. Arrivals to Chicago are lumped together for both winter and summer types and there are many varieties of each. There are no data for per capita consumption. Yet, because squash is very easy to grow in Iowa, squash is

produced by a number of growers though little is known about the level of supply necessary to meet demand.

Estimates of per capita demand were derived from the Chicago arrivals data and from the ISU survey data. By using the Chicago arrivals data, it was found that Georgia supplied some squash in the early and late market, with Florida entering in October. Local suppliers such as Illinois, Indiana, and Michigan supplied the major portions of the Chicago market in all periods.

Of the three local states supplying Chicago, none were found to have squash production cost budgets available; consequently, Missouri's squash budgets were used as an approximation for these three states. Squash production data were not available for a revenue time series. Hence, risk could not be analyzed as a part of the study.

Iowa has the cost advantage in the production of both types of squash, but summer squash results were fairly responsive to cost estimation error while winter squash was not. A 20-percent increase in costs was necessary to change the results for summer squash and a 50-percent increase was necessary for winter squash. A 100-percent increase in labor costs was necessary to switch from Iowa to Missouri for summer squash. Labor cost increases also had little impact on winter squash results.

Tomatoes

A number of states supply tomatoes to Chicago according to the arrivals data. California, however, is the single largest supplier of tomatoes, with approximately one-half or more of the total. Only in August do they slip to one-third of the market and local suppliers pick up one-third of the market. Texas, Florida, Georgia, and North Carolina are minor suppliers of tomatoes in the transitional market periods of July and October. Ohio also is a minor

supplier in the transitional months, but is as large as either of the local states, Illinois and Michigan, during August and September.

Iowa again has a cost advantage in the production of tomatoes. Large errors in the yield estimates would be necessary to change these conclusions. There were no changes in the results after a 30-percent decrease in yields, and Michigan became a supplier only after a 40-percent decrease in the Iowa yield. California production entered the results after a 50-percent decrease in Iowa's yield. Because tomatoes were fairly labor intensive, a doubling of the labor costs decreased the amount of tomatoes being produced by Iowa but did not change supply regions from the original conclusions.

Although these results indicate that tomatoes can be grown profitably in Iowa, they should be viewed skeptically. The percentage of locally grown tomatoes on the Chicago market is fairly low even at the peak of the harvest season, so there must be some reason why California enjoys a large measure of success in these markets, even if tomato production is less costly in local areas. A portion of their success is due to consumer recognition of California tomatoes by taste. In a taste test completed at the 1985 Iowa State Fair, 50-percent of the people preferred the taste of the California-grown tomato to the Iowa-grown tomato (personal communications with Camille Valley, Iowa Department of Agriculture). This indicates a consumer preference for a particular flavor of tomato or an inability to distinguish between locally grown and California-grown tomatoes. Also, during the ISU survey of midwestern buyers, all but those in Chicago indicated that they preferred to buy "gas green" tomatoes--green tomatoes that are ripened artificially with ethylene gas--from California. Therefore, even though production cost information indicates that tomatoes could be grown at a lower cost in Iowa, there are indications that consumers prefer California's tomatoes.

Watermelons

Watermelons, like muskmelons, tend to have a highly seasonal demand. Demand rises during July, peaks in August, declines rapidly through September, and is negligible in October. Florida and Georgia are transitional suppliers of watermelons in both the early and late market periods. Texas is primarily a transitional market period producer. Local producers, Illinois and Missouri, supply the largest portion of watermelons shipped to the Chicago market during August and September. Iowa also ships a small quantity during August according to the USDA Chicago arrivals data.

Iowa is a residual supplier of watermelons in our analysis of the commercial wholesale market. Both Illinois and Missouri claim to have a lower per unit cost of production. A small 10 percent increase in Iowa's yield however, gave Iowa the cost advantage except in early-period production. Missouri held the advantage in July production even after yields were increased by 50 percent, although Illinois dropped out after Iowa's yield increased 30 percent. There was evidence that growing practices such as transplants and plastic mulch to enhance early harvest do not pay off.

On the other hand, an Iowa yield decrease did not change supply regions until Iowa's yield had decreased by approximately 30 percent. Then Georgia and Texas entered in all market periods. Florida did not enter the market until a 50-percent decrease in costs was imposed. This indicates that Iowa producers could, with only a small increase in yield, be competitive with other midwestern states. At the same time, Iowa yields are high enough that Florida and Georgia pose no threat should Iowa produce for the commercial market. Thus, in August and subsequent months, better Iowa producers should be able to compete with other local states for the commercial wholesale market.

Crop summary

Table 6 summarizes the suppliers with the competitive edge and their possible market shares in the Iowa market. These results only encompass those crops for which both price-quantity relationships and risk could be evaluated. Broccoli and the squashes were only evaluated in terms of least cost producing areas. Leaf lettuce could not be evaluated because competing states did not have budget information.

Opportunities for Iowa producers in the metropolitan markets

A similar analysis to the one accomplished for the Iowa market was attempted for the four nearby metropolitan areas. Preliminary results indicate there could be some opportunities for Iowa producers to enter markets in broccoli, snap beans, cucumbers, muskmelons, potatoes, and tomatoes. These are the same crops for which Iowa held a cost advantage in the Iowa market. The same precautions should be applied to these markets as were applied to the Iowa market. Buyers have been hesitant to deal with local growers because growers lack sufficient cooling and industry-standardized boxes. In addition, there may be some nonquantifiable marketing costs that may limit Iowa growers success in these markets. These costs may include overcoming marketing hurdles for new entrants such as establishing the grower's reputation and having the local product accepted as a quality product in the eyes of the consumer. Even though the results indicate some potential for Iowans to penetrate the market, unforeseen costs could eliminate them from competition.

Implications for Iowa Agriculture

In the previous sections, the results of this study have been discussed and analyzed. In this section those results will be transformed into acres of

Table 6. Suppliers and Percent Market Shares for Selected Crops by Market Period

Crop/State	Month				
	June	July	August	September	October
Snap beans					
Iowa	100	100	100	100	100
Cabbage					
Iowa	88	14	4	5	6
Illinois	12	86	96	95	94
Sweet Corn					
Iowa		68		11	71
Illinois		32	100	84	20
Ohio				5	9
Cucumbers					
Iowa		100	100	100	100
Muskmelons					
Iowa		96	100	100	100
Illinois		4			
Green Peppers					
Iowa		61	38	33	83
Illinois		6	54	44	13
Michigan			8	23	2
Florida		6			2
Georgia		27			
Potatoes					
Iowa		100	100	100	95
Washington					5
Tomatoes					
Iowa		100	100	100	100
Watermelons					
Iowa		23	40	50	89
Illinois		1	26	33	5
Missouri		18	34	17	6
Texas		13			
Georgia		45			

crops that are necessary to meet demand in the Iowa commercial wholesale fresh market. Table 7 summarizes those results. Dividing the assumed quantities demanded by the assumed yield per acre indicates the potential acres that are needed to meet current demand and maintain 1984 price levels. "Best Estimate Acres" indicates the acres under the most realistic scenario of the model when risk is included in the analysis; "No Risk Estimate of Acres," indicates the results if all producers were unaffected by risk.

Note that in certain instances the acres reported are greater than the potential available. In these instances more than 100 percent of the current quantity demanded by the consuming public was being supplied by Iowa producers. This occurred because Iowa's costs were substantially below current costs by outside producers. With low costs and prices, consumption would increase but the precise changes are difficult to measure. Where the predicted quantity supplied exceeded 150 percent of current consumption it was truncated at the 150% level. For these crops, specifically snap beans, cucumbers, muskmelons, and tomatoes, prices would be expected to fall from current levels because of the drastic shift in the supply curve. Given that Iowa produces at considerably less cost than their competitors, prices would clearly fall to bring profits and risk back into equilibrium, other factors being equal.

The potential acres needed to meet demand is approximately 5000. The best estimate of Iowa's potential is for approximately 3900 acres of the crops included in this study. Without risk and with crops limited to a maximum of 150 percent of current consumption, approximately 6600 acres of crops were necessary to satisfy Iowa's needs. This difference in vegetable-crop acreage is mainly due to increased potato production in all market periods and the

Table 7. Demand for Fresh Vegetables in the Iowa Commercial Wholesale Fresh Market and Estimated Acres to Meet Demand

Crop	Expected Yields /Acre (Cwt.)	Summer Demand (Cwt.)	Estimated Potential Acres	Best[a] Estimate of Acres	No Risk[b] Estimate of Acres
Broccoli	50.00	7585	151.7	151.7	151.7
Snap beans	101.50	12840	126.5	189.8	189.8
Cabbage	250.00	78788	315.2	57.3	315.2
Sweet corn	95.00	87456	920.6	151.1	979.3
Cucumbers	393.75	26796	68.1	94.2	102.1
Muskmelons	250.00	121744	487.0	549.8	713.7
Leaf lettuce	150.00	5050	40.3	40.3	40.3
Green peppers	87.00	21670	249.1	137.8	253.9
Potatoes	250.00	407407	1629.6	1722.1	2444.4
Summer Squash	300.00	3822	12.7	12.7	12.7
Winter Squash	300.00	1242	4.1	4.1	4.1
Tomatoes	300.00	88838	296.1	444.2	414.5
Watermelons	200.00	136001	680.0	344.2	976.0
Total Acres			4981.0	3899.2	6597.7

[a]The "Best Estimate" refers to the potential number of acres of crops that Iowa has some competitive advantage to produce when all factors of the analysis are included.

[b]The No Risk Estimate refers to the potential number of acres in our conclusions if risk was not accounted for in our analysis.

expanded crop production by Iowa of cabbage and sweet corn when risk is not considered in the analysis.

Perhaps the most difficult part of this analysis was to predict the number of acres that could replace corn and soybean acreage. The upper limit on the total acres necessary to meet Iowa's demand for the 13 fruits and vegetables in this study is approximately 6600 acres. This value, however, is optimistic because it allows supply of almost all crops to move down their demand curves to a point where the quantity supplied is 150 percent of the predicted quantities demanded in 1984. The demand curves used in this analysis are only good predictors near the current consumption levels, so prices could fall off considerably if 150 percent of current demand were produced, and actual acreage could be less than 6600 acres. The 3900 acres predicted in the best estimate is probably less than that which could be grown by Iowa producers. This is because certain crops such as sweet corn appear to enter a portion of the commercial wholesale market without the precooling that sweet corn shipped from outside the state must have to maintain shelf life.

Current production levels in Iowa are not well known. The room for expansion, given this study's best estimate, is shown in Table 8. The estimate in the first column assumes that none of the producers in Iowa produce for the commercial wholesale fresh market. But, USDA data shows that Iowans do grow approximately 1600 acres of potatoes for the commercial wholesale fresh and processing markets. Thus, the potential would be for the 3899 acres predicted by the model minus those 1600 acres of potatoes grown for commercial wholesale fresh or processing markets. Even that is not a good estimate because Agricultural Statistics does not separate processing acres

Table 8. Predicted Expansion Potential for Horticulture Crops In Iowa

Crop	Best Prediction (Acres)	1982[a] Study (Acres)	1985[b] Study (Acres)	Potential Expansion as the difference between the best prediction and each study	
				1982 Acres	1985 Acres
Broccoli	150	7	0	143	150
Snap beans	190	34	0	156	190
Cabbage	57	105	200	0	0
Sweet Corn	151	5619	3700	0	0
Cucumbers	94	29	0	65	94
Leaf lettuce	40	0	0	40	40
Muskmelons	550	429	800	121	0
Green peppers	138	75	80	63	58
Potatoes	1722	1767	600	0	1122
Squash	17	97	250	0	0
Tomatoes	444	473	60	0	384
Watermelons	344	345	700	0	0
Total Acres	3899	8980	6390	588	2038

[a]Acres listed in the 1982 Census Agriculture, U.S. Department of Commerce, 1984.

[b]Acres listed by ISU Department of Horticulture Study.

from fresh tablestock potato acres; 2300 acres would likely be an underestimate of the acreage that Iowa could competitively produce for self sufficiency in fresh vegetables. Two additional sources of data were used to find a benchmark from which to estimate potential expansion acreage. Each source had its problems. The 1982 Census of Agriculture (U.S Department of Commerce, 1984) estimates acreage may have changed by 1984. And, even if those acreages were comparable, those estimates included processing acres that are not included in this study. Furthermore, this study assumes irrigated land is necessary to obtain the yields assumed, and only about 800 acres were irrigated in the 1982 study.

The 1985 data set has similar difficulties. It is based on the best estimate of Henry Taber, the ISU State Extension Horticulturist. Both acres and yields could be suspect because there was no actual data collected, just a recollection of acreages and yields seen or heard, and his estimates are based on 1985 rather than 1984. But these sources help estimate lower limits on the expansion potential for Iowa.

Table 8 shows the acreage difference between this study's best prediction and both the 1982 and 1985 acreage data sets. Both acreage estimates (USDA and Taber) indicate that there are almost no current acres in broccoli, snap beans, cucumbers, and leaf lettuce. Sweet corn, cabbage, and squash seem to be near potential demand if they are supplied direct to the retail outlet. The potential expansion in squash acreage however, could be considerably underestimated in this study.[1] There may be some room for expansion in

[1]According to ISU's estimates during their survey of Chicago buyers, USDA arrivals in Chicago seemed to underestimate the quantity demanded by 2 to 5 times. One possible explanation for this contradiction in data is that buyers may have the deliveries made directly to the stores and not through the main distribution warehouse. Thus, they may miss being counted by USDA data collectors.

muskmelon, green peppers, potatoes, and tomatoes. These crops take considerable expertise to grow for the commercial market and would require skill in production and marketing.

Given this information and assuming the sweet corn, cabbage, and squash markets are saturated and that approximately 600 acres of potatoes are being grown in Iowa for the fresh market, the potential for expansion for these crops would be approximately 3100 acres. This assumes that in the markets other than sweet corn, cabbage, and squash the considerable post-harvest handling procedures have kept most of the current producers from entering the commercial wholesale markets and that currently most of the production is being marketed directly to the consumer.

Small farm opportunities and economic impacts for Iowa

One reason this study was undertaken was to find whether profitable vegetable production opportunities existed for small farmers. Consequently, the budgets estimated for Iowa were based on a machinery complement for a 40-acre farm. Our research indicates that opportunities exist for approximately 75 small farmers.

Most policymakers are interested in the impact that introduction of the alternative crops would have upon agricultural economy. By using this study's best estimate of the totals production needed for the 13 crops for which Iowa has some cost advantage, the total sales at the wholesale level that these crops would bring farmers are $17.08 million. If Iowa farmers were to capture the entire market (which is somewhat unlikely), the total would be $17.22 million.

Summary

This paper has discussed Iowa's economic production potential for fresh commercial wholesale vegetables. The study was designed to determine Iowa's summertime competitors and the comparative costs of producing and marketing 13 major vegetables: broccoli, snap beans, cabbage, sweet corn, cucumbers, leaf lettuce, muskmelon, green peppers, potatoes, summer and winter squashes, tomatoes, and watermelon. Also studied were the effects production risk would have on the overall willingness of Iowa producers to switch from their more traditional, less risky crops, corn and soybeans, to the more risky vegetable crops.

Because of the nature of the data available, several tests were made to analyze how much error in cost data estimation was allowable without changing the results. In addition, this study tested the effects that rising energy and transportation costs would have on the location of production. Lastly this research examined the effects of increasing labor costs in Iowa upon the ability to substitute Iowa production for the current suppliers' production. Iowa has a cost advantage in the production of snap beans, cucumbers, muskmelons, potatoes, and tomatoes. If risk is not a factor in the decision-makers criteria, then Iowa also would have a cost advantage in cabbage and sweet corn. Results for broccoli, green peppers, potatoes, and summer squash were very sensitive to cost estimation errors; therefore, the cost advantage could be in some question for these crops. Only minor increases in yield were necessary to give Iowa the cost advantage in the production of cabbage, sweet corn, early muskmelons, and watermelons.

Approximately 5000 acres would meet Iowa's demand in the commercial wholesale market for the 13 fruits and vegetables included in this study but Iowa only has the cost advantage for approximately 3900 acres. The 3900 acres

would bring approximately $17.08 million to the Iowa farm economy. There are approximately an additional 3100 acres that are not currently in production in Iowa. This could translate to approximately 75 small farms of about 40 acres in size, which was the base for the budgets included in this study. Clearly this is very small compared to the 22 million acres of corn and soybeans grown annually in Iowa. While not insignificant for a small number of producers, the overall potential contribution of commercial fresh vegetables production for wholesale markets to diversification of Iowa agriculture appears to be small.

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